

Answers

Chapter 6 The digestive system supplies nutrients for the body

Questions 6.1

Recall knowledge

1 List the types of digestion.

Answer: Mechanical digestion, chemical digestion

2 Complete the following table.

Answer:

Large, complex molecule	Small, simple molecule
Protein	<i>Answer:</i> Amino Acid
<i>Answer:</i> Carbohydrate	Monosaccharides
Triglycerides (lipids)	<i>Answer:</i> Monoglyceride, 2 fatty acids

3 Describe the purpose of digestion.

Answer: To extract the nutrients from the food we eat and absorb them for use by the cells.

Apply knowledge

4 List two similarities and two differences between mechanical and chemical digestion.

Answer: Similarities: Both take something larger and make it smaller. Mechanical and chemical digestion occurs in the mouth, stomach and small intestine.

Differences: Mechanical digestion is a physical process, so no new substances are formed.

Chemical digestion produces new products from larger, more complex molecules. Chemical digestion requires enzymes, mechanical digestion does not.

5 People who have had their gall bladder removed are unable to control the release of bile into the small intestine. Predict a consequence of this.

Answer: They will have difficulty digesting fats, which may lead to diarrhoea.

Questions 6.2

Recall knowledge

1 List the structures of the alimentary canal in order, starting from the mouth.

Answer: Mouth → pharynx → oesophagus → stomach → small intestine → large intestine → rectum → anus

2 Which is longer: the oesophagus, small intestine or large intestine?

Answer: The small intestine

3 List the enzymes that are present in pancreatic juice.

Answer: Pancreatic amylase; Pancreatic protease / trypsin; Pancreatic lipase; Deoxyribonuclease and ribonuclease

4 Describe the function of the large intestine.

Answer: To absorb water and mineral nutrients and to form faeces.

5 What type of digestion (mechanical or chemical) occurs in the stomach?

Answer: Both types occur in the stomach. Mechanical digestion occurs with the stomach, churning the food and producing chyme. Chemical digestion of proteins occurs with the release of pepsin.

Apply knowledge

6 Explain how the lining of the small intestine maximises the absorption of nutrients.

Answer: The lining of the small intestine (mucosa) is folded to increase the surface area. The mucosa has small projections called villi; the villi have microvilli projecting from the external surfaces. This increases the surface area to allow for maximum absorption of nutrients.

7 Explain the role of hydrochloric acid in the stomach.

Answer: The hydrochloric acid activates pepsinogen and converts it to an active form of the enzyme called pepsin. The hydrochloric acid also creates an environment that will destroy any bacteria or pathogens that have been ingested.

8 Herbivores, such as horses, have reduced canines and large premolars and molars. Explain the relevance of this.

Answer: Canines are used for tearing, which is needed more by carnivorous animals than herbivores. Large premolars and molars allow for grinding and crushing food to access the nutrients found in plant material, which is why herbivores have larger molars and pre-molars.

Questions 6.3

Recall knowledge

1 What is the common name for colorectal cancer?

Answer: Bowel cancer

2 List two conditions that are more likely with a diet low in fibre.

Answer: Bowel cancer, diarrhoea, constipation

3 Define 'diarrhoea'.

Answer: Frequent defecation of watery faeces caused by irritation of the small or large intestine.

Apply knowledge

4 Explain the difference between diarrhoea and constipation.

Answer: Diarrhoea is frequent passing of watery faeces, whereas constipation is a condition where defecation is difficult because the faeces have become hard and dry.

5 Identify the treatment for coeliac disease and justify its effectiveness.

Answer: The treatment is to follow a gluten-free diet. This is because the presence of gluten (a protein found in wheat, barley and rye) causes the immune system to damage and destroy the villi in the small intestine, which leads to a lack of nutrients being absorbed and malnourishment.

6 Explain the relationship between peristalsis and diarrhoea.

Answer: Peristalsis is the rhythmic contraction of the smooth muscle of the alimentary canal used to propel food along the tubes. Diarrhoea occurs because of rapid peristalsis, moving the contents of the intestine more quickly, limiting the absorption of water.

7 Explain why it is important for people to eat fruit and vegetables.

Answer: Fruit and vegetables contain cellulose/insoluble fibre. Although we are unable to digest cellulose, it is required to help move the contents of the intestine along. Without it, the movements of the large intestine become slower, more water is absorbed, and constipation can result.

Chapter 6 activities

Activity 6.1 Investigating amylase metabolism

Discussion

1 What is your independent variable?

Answer: The temperature at which the samples are incubated.

2 What is the range of your independent variable?

Answer: 0–80°C

3 What is your dependent variable?

Answer: The time taken for the iodine to change colour

4 Explain why the enzyme activity differed at 0°C compared to 100°C.

Answer: Enzyme activity at 0°C is very slow but will work eventually. At 100°C, the enzyme is denatured and so should not work at all.

5 Why does the iodine solution change colour when the amylase-starch solution is added?

Answer: Starch and iodine form a complex. This complex results in a deep blue colour. As the starch breaks down, the starch-iodine complex is lost.

6 Why does the iodine solution stop changing colour as the experiment progresses?

Answer: Once the starch has broken down and the blue colour is lost, the brown that the solution becomes is the colour of the iodine itself.

7 Why are all the test tubes left in the water baths for five minutes before two solutions are added together?

Answer: If the amylase and starch are added together before they have reached the desired temperature, there will be some activity happening at an unknown temperature, which could affect the results. For example, if the 80°C amylase is added to the starch before it becomes denatured, the starch will begin to break down.

8 Why was it important to keep the test tubes in the water bath at all times?

Answer: To keep the temperature stable throughout the experiment. Otherwise, it will start to warm up or cool down to room temperature, affecting the amylase activity.

9 How accurate do you believe your collected data is? What may have influenced this accuracy? How would you modify the experiment to improve the level of accuracy?

Answer: Answers will vary. Students may cite possible sources of error such as when the decision is made that the colour has finished changing, or temperature of solutions, particularly if hotplate/beaker water baths are used. Possible modifications may include testing more frequently, using a controlled water bath, incubating tubes for longer.

Activity 6.2 Investigating the action of pepsin

Discussion

1 Why was the water added to test tubes 1 and 2 in those specific quantities?

Answer: The three drops of distilled water added to test tube 1 is a substitute for the HCl, and 1 mL of water added to test tube 2 is as a substitute for the pepsin. This will remove any question as to whether any change in appearance is due to the extra dilution caused by the addition of those reagents.

2 Why is the albumin suspension cloudy? What is suggested by the clearance of the cloudiness?

Answer: The albumin is not completely soluble until the pepsin has broken it down into smaller molecules. Clearance of the cloudiness suggests that the molecules have been broken down enough to dissolve.

3 What does the result in test tube 4 suggest?

Answer: From the lack of change in test tube 4, students should be able to surmise that the enzyme has not worked. Being a protein, pepsin is denatured by very high temperatures and so boiling has rendered it unable to digest the albumin.

4 What does the result in test tube 2 suggest?

Answer: Test tube 2 contained HCL, but no pepsin and produced cloudy results. This suggests pepsin is responsible for clearing the albumin observed in test tube 3, rather than the HCl itself which may have been a hypothesis.

5 Compare the results of test tubes 1 and 3. What can you infer from this comparison?

Answer: A comparison of the results of test tubes 1 and 3 should indicate that pepsin will work without the acid, but not as efficiently.

6 Antacids are bases that reduce the amount of acid in the stomach. This can reduce the discomfort associated with a highly acidic stomach environment. What might happen if more than the recommended number of antacids were consumed in a short period?

Answer: An overdose of antacids could raise the pH of the stomach beyond the ideal range of pepsin, slowing down or halting digestion.

7 Can you think of another function of stomach acid besides digestion?

Answer: The acidic environment can destroy bacteria or other harmful microbes before they reach the intestines.

Activity 6.3 Investigating pancreatic juices

Discussion

1 What is the control in this experiment?

Answer: The control is test tube 2, as 5 mL water is added to test tube 2 rather than the 5 mL of pancreatin solution that was added to test tube 1.

2 In which test tube were proteins and lipids digested? How do you know?

Answer: Digestion happened in test tube 1. The colour change of the litmus from blue-purple to red-purple indicates a reduced pH, and therefore the presence of the acids produced by digestion.

3 Explain the process behind the change in pH

Answer: Amino acids and fatty acids are byproducts of protein and lipid digestion respectively. Being acids, their formation will reduce the pH.

4 What role did trypsin play in this procedure?

Answer: Trypsin hydrolysed the proteins, to produce amino acids.

5 What role did lipase play in this procedure?

Answer: Lipase digested the lipids to produce fatty acids.

6 Why did you have to place the test tubes in a water bath at 37°C? What is your hypothesis if this temperature was increased to 80°C? Decreased to 5°C?

Answer: The optimum temperature of enzymes is approximately human body temperature (37°C). If the temperature were increased to 80°C, the enzyme would be denatured and digestion would not take place. If it were reduced to 5°C, it is likely that the pancreatin would slow or cease its function.

The sample heated to 80°C may have some digestion if the pancreatin is added to the milk before heating, but once it is denatured no further digestion will occur even if the solution is cooled down. The sample cooled to 5°C would start to work again if the solution is warmed.

Chapter 6 review questions

Recall

1 Draw up a table with three columns. In the first column, list the parts of the alimentary canal that are discussed in this chapter. In the second column, describe the role of each part in digestion and absorption. In the third column, explain how the structure of the part is suited to its functions. Remember to put an appropriate heading on each of your columns.

Answer:

Organ	Function/role in digestion and absorption	Structure suited to the function
Mouth	Mechanical digestion by teeth as they break food into small pieces; chemical digestion by saliva; forms bolus of food	Moist and has three pairs of salivary glands; teeth shaped for biting, tearing, crushing and grinding; tongue is a strong muscle that moves food
Oesophagus	Carries food from mouth to stomach	Muscular tube that can push food toward stomach; has moist lining (slippery); circular and longitudinal muscle to push food along by peristalsis
Stomach	Mechanical digestion by churning food into liquid; chemical digestion of proteins by pepsin; stores food as it is eaten; absorbs some substances, such as alcohol	Muscular sac containing gastric glands that secrete digestive juices; secretes mucus to protect surface; glands secrete HCl to produce low pH; circular, longitudinal and oblique muscle layers allow churning motions to mix food with stomach juices
Small intestine	Mechanical digestion continues with churning of food, and bile salts added to emulsify fats; chemical digestion of all nutrients by enzymes from pancreas and	Very long (6 m) muscular tube with folded inner lining or mucosa that has a vast surface area for maximum absorption due to villi and microvilli; vascular/networks of blood vessels to absorb

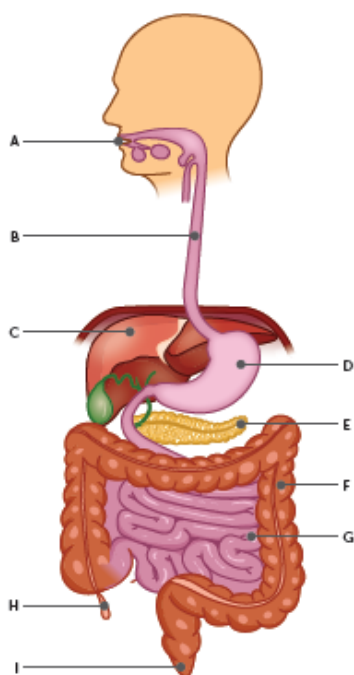
	intestinal glands; absorbs water and digested food.	nutrients and water; lymph capillary in each villus to absorb lipids
Large intestine	Water, vitamins and mineral nutrients absorbed; faeces formed and stored	Long tube; contains bacteria that produce vitamins; larger diameter than small intestine to store faeces

2 What are the basic activities that the digestive system must carry out?

Answer:

- Ingestion of food and water
- Mechanical digestion of food
- Chemical digestion of food
- Movement of food along the alimentary canal
- Absorption of water and digested food into the blood and lymph
- Elimination of material that is not absorbed

3 Label the parts of the alimentary canal on the diagram below.



Answer:

- A – Mouth
- B – Oesophagus
- C – Liver
- D – Stomach
- E – Pancreas
- F – Large intestine
- G – Small intestine
- H – Appendix
- I – Anus

4 Name the enzyme(s) that break down:

a proteins

Answer: Pepsin, pancreatic protease, peptidase

b complex carbohydrates

Answer: Salivary amylase, pancreatic amylase, amylase

c lipids

Answer: Pancreatic lipase, lipase

Explain

5 Explain the digestive function of each of the following:

a gastric juice

Answer: Gastric juice contains hydrochloric acid, mucus and digestive enzymes. Chemical digestion of proteins is begun by the enzyme pepsin contained in the gastric juice. Pepsin works in an acid medium to break down proteins to polypeptides.

b bile

Answer: Bile does not contain any digestive enzymes, but bile salts act like a detergent and emulsify the fat, breaking it into tiny droplets. This is a form of mechanical digestion, increasing the surface area on which the lipases can act to cause the chemical breakdown of fat.

c pancreatic juice

Answer: Pancreatic juice is alkaline and helps to neutralise the acid that has come with the material from the stomach. Many of the enzymes involved in the digestion of food are contained in pancreatic juice. These include:

- pancreatic amylase, which breaks down starch
- trypsin (or pancreatic protease), which splits proteins into much smaller units
- ribonuclease and deoxyribonuclease, which are enzymes that digest RNA and DNA
- pancreatic lipases, which are enzymes that break down fats into fatty acids and glycerol.

d intestinal juice.

Answer: Intestinal juice contains many enzymes that complete the digestion of carbohydrates, fats and proteins.

6 Explain the difference between excretion and elimination.

Answer: Elimination is the removal of the undigested material that remains after food has passed through the alimentary canal. Excretion is the removal of metabolic waste – waste produced by chemical processes inside the body's cells.

7 To be effective, any surface where materials are taken into or passed out of the body must have a very large surface area. Explain how a large surface area is achieved in the part of the digestive system where nutrients are absorbed.

Answer: Most nutrients are absorbed in the small intestine where a large surface area is achieved by:

- the length – approximately 6 m
- folding of the internal lining
- villi on the surface of the mucosa
- microvilli extending from the cells on the outside of the villi.

Apply

8 What effect would each of the following have on the speed with which food moves through the alimentary canal?

a Consuming a very large meal

Answer: The larger the meal, the greater the distension of the stomach muscles and the faster the food moves into the small intestine.

b Eating a meal that is very high in fat

Answer: A high fat meal slows the rate of stomach emptying – the food moves into the small intestine much more slowly.

c Consuming alcohol

Answer: Alcohol tends to increase the rate of stomach emptying although a large amount of alcohol may slow the rate.

9 a Describe the cause of constipation.

Answer: Constipation may be caused by many different things including:

- A low fibre diet, or a diet high in meat, milk and cheese.
- Dehydration
- Lack of exercise
- Delaying the impulse to have a bowel movement
- Travel or changes in routine
- Certain medications or a misuse of laxatives
- Pregnancy

b What precautions can you take to prevent constipation?

Answer: Constipation may be caused by a lack of roughage in the diet. Roughage is cellulose, or insoluble fibre, a major component of plant foods. Eating more fruit and vegetables, and drinking more water, helps prevent constipation. Exercise also helps because it stimulates bowel movements.

10 Why are people who suffer from coeliac disease likely to become malnourished?

Answer: People with coeliac disease are unable to tolerate a protein called gluten, which is found in wheat, rye and barley. If coeliac sufferers eat food containing gluten, their immune systems respond by damaging or destroying the villi in the small intestine. Without healthy villi, nutrients cannot be absorbed, and the sufferer becomes malnourished no matter how much food is eaten.

Extend

11 Absorption of nutrients depends on concentration differences so that substances diffuse across the absorbing surface. Explain how the concentration difference is maintained in the parts of the alimentary canal where absorption occurs.

Answer: Blood flows through the capillaries of the mucosa, so that, as nutrients are absorbed, they are constantly removed. The movement of the villi, peristalsis and segmentation of the intestinal wall keep bringing new contents into contact with the absorbing surfaces.

12 Explain why some food substances (such as starch) have to be digested but others (e.g. salt) do not.

Answer: Large molecules have to be broken down (digested) into smaller molecules so that they can be absorbed through the lining of the alimentary canal into the blood or lymph. Large molecules, such as starch, have to be digested, but small molecules, such as salt and vitamins, are already small enough to be absorbed.

13 The most common treatment for bowel cancer is to surgically remove the part of the bowel containing the cancer. Suggest what effects removal of part of the large intestine may have on a person's normal functions.

Answer: After surgery, the large intestine will be shorter than before so the contents will pass through more quickly. Faeces may be more watery because there is less surface area in the bowel for absorption of water. It may also be necessary for some patients to go to the toilet more often. Some patients experience constipation after surgery because the damage to nerves and muscle caused by the surgery may slow peristalsis in the bowel.

14 Use a flow chart to outline the process of digestion of a piece of ham, which is a protein.

Answer:

